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Original Article

Pediatric Pneumonia: A Review of Clinical Practice Essentials – A Clinical Study in a Tertiary Hospital

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Abstract

Background: Lower respiratory tract infections are common cause of morbidity in infants and preschool children. Among them, infectious pneumonia is foremost in causing serious illness and creates problems in its diagnosis. Determination of exact etiology of pneumonia is uncertain due to difficulty in obtaining suitable and adequate samples and shortage of accurate diagnostic methods.

Aim of the Study: The aim of the study was to review the clinical diagnosis, investigations, diagnosis, and management of pneumonia in children in the light of the WHO guidelines.

Materials and Methods: A total of 79 children with pneumonia attending a tertiary teaching hospital were included in the study. Children aged between 2 and 59 months were included in the study. Children satisfying WHO criteria for the diagnosis of pneumonia were included from the study. Children with documented evidence of comorbidities were excluded from the study. Demographic data, nutrition history including breastfeeding practices, immunization history, and treatment history, were elicited. Children were divided as Group A: Children with weight for age <3rd percentile, and Group B: Children with weight for age ≥3rd percentile. Investigations included radiological, hematological investigations such as complete blood picture, sputum examination, and nasopharyngeal aspirates analysis for organism and blood cultures were done. All the children were treated following the WHO guidelines. The hospital stay was grouped as <1 week group and more than 1 week group.

Observations and Results: Among 79 children there were 43 (54.43%) male children and 36 (45.56%) female children. The youngest child was 2 months old and the eldest child was aged 57 months old with a mean age of 28.4 ± 1.3 months. Children belonging to Group A were 40 (50.63%) and belonging to Group B were 39 (49.36%). Among 79 children, 46/79 (58.22%) were diagnosed as "Pneumonia" and the remaining 33/79 (41.77%) children as severe pneumonia. 62/79 (78.48%) children below 36 months (3 years) were found to have either pneumonia or severe pneumonia. 17/79 (21.51%) children belonged to the age group above 36 months were found to have either pneumonia or severe pneumonia in this study. 39/62 (62.90%) children who had pneumonia were below 36 months and 23/62 (37.09%) children who had severe pneumonia were below 36 months.

Conclusions: Pneumonia is a clinically curable disease when identified and initiated on recommended treatment protocols. Lack of exclusive breastfeeding till 6 months of age, failure of complete immunization coverage, child malnutrition, infancy, and toddler age are the risk factors for both types of the pneumonia but more so with severe pneumonia. There was no statistical significance correlating the X-ray findings and severity of pneumonia was observed.

Key words: Atypical pneumonia, Breastfeeding, Children, Infections, Malnutrition, Pneumonia

INTRODUCTION

Pneumonia is a common pediatric disease with significant mortality. Every year nearly 1.6 million children die from pneumonia.[1] The pneumonia etiology research for child health (PERCH) study is the largest multicenter study of childhood pneumonia in the present times, which helps in defining pneumonia according to their etiology, predisposing factors, investigations, and management.[2] In 2015, the maternal and child epidemiology estimation group of the WHO reported mortality of an estimated 0.9 million children all over the world under-five age group. This observation was made from the WHO global health observatory data and declared that pneumonia continues to be the leading cause of death among children in developing countries.[3] In India 143,286 children aged

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<5 years were reported to have died due to pneumonia in the post-neonatal period during the year 2015 contributing to 28% of post-neonatal deaths.[3] The case fatality rate due to pneumonia among hospitalized children aged 1 month–59 months reported was 8.2%.[4] It was reported that factors such as age of the child, nutrition state, and breastfeeding practices, vaccination status, bacterial profile and associated congenital anomalies determined the severity of pneumonia, and mortality due to pneumonia. The WHO panel of experts redefined the severity of pneumonia as "pneumonia:" Child with fast breathing and/or chest in drawing and "severe pneumonia:" Pneumonia with any general danger signs.[5] The aim was to study the clinical profile, risk factors of pneumonia and to determine the bacterial etiology of pneumonia in children. The clinical conditions enumerated under the definition of pneumonia by WHO includes: Bacterial and viral pneumonia, acute viral bronchiolitis, and bacterial and viral bronchitis which can coexist and duel pathogens are can occur commonly, especially in critically ill children in low-resource settings. In many of pneumonia in children, they start with an acute viral infection followed by mucosal invasion or drip aspiration of nasopharyngeal (NP) bacteria. The NP colonization of bacteria in children varies from 95% in the first 2 months of life to 30% by age 1–5 years; so as the risk of bacterial pneumonia accompanying a viral upper respiratory tract infection also varies greatly.[6-8] In the lancet, the PERCH study group from their study reported that ten pathogens accounted for almost 80% of WHO-defined pneumonia in the cases studied. The top ten list of pathogens varied between sites, but the universal causes included respiratory syncytial virus (RSV), *Streptococcus pneumoniae*, parainfluenza virus, *Haemophilus influenzae*, human metapneumovirus, and *Mycobacterium tuberculosis*. However, the incidence of pneumococcal infections by PERCH was low.[9] Only 31.7% of children in the PERCH study had wheeze on auscultation, 52.5% had no consolidation or opacification on chest X-ray, and 31.1% had RSV, suggesting that many cases had viral bronchiolitis (with or without pneumonia).[10] The International Classification of Diseases (ICD) or the WHO radiographic criteria for pneumonia[9] are different from the WHO clinical criteria.[10] ICD criteria for pneumonia exclude clinical bronchiolitis and, thus, the prevalence is not diluted by all cases with severe acute lower respiratory infections, unlike in the PERCH cohorts. The threshold for pneumonia with positive chest X-ray in the PERCH study was defined as "consolidation, other infiltrate, or both," and viruses (including in viral bronchiolitis) can be associated with infiltrates on chest X-rays.[11,12] The typical predisposing factors in very severe acute lower respiratory infections in low-income countries often includes household overcrowding and possible genetic factors (which lead to dense bacterial colonization of the upper airway), smoke exposure, viral respiratory infections, and insufficient breastfeeding and early solid feeding (leading to breaches in barrier and mucosal immunity and drip aspiration of *S. pneumoniae* and *H. influenzae*).[13] The new WHO recommendations for policy-making and practice of treating pneumonia were called as "Grading of recommendations, assessment, development, and evaluation" with available evidence profiles, and to deliberate the factors that determined the strength of the recommendations. The first consultation for preventing and managing pneumonia in HIV-infected and HIV-exposed infants and children; these were published in 2010.[2] The second consultation for managing pneumonia in non-HIV affected infants and children was published in 2012.[2] The revisions include changing the recommendation for the first-line antibiotic and re-defining the classification of pneumonia severity. In this context, the present study was conducted to review the essential practices of treating pneumonia in children.

MATERIALS AND METHODS

Seventy-nine children diagnosed with pneumonia attending the Department of Pediatrics of a tertiary teaching hospital were included in the present study. An ethical committee clearance was obtained before the commencement of the study. An ethical committee cleared consent form was used for this study. The period of study was from January 2017 to December 2018.

Inclusion Criteria

- Children aged from 2 months to 59 months were included in the study
- Children presenting with complaints of fever, cold, cough, shortness of breath, and increased respiratory rate with chest in drawing satisfying WHO criteria for pneumonia were included in the study.

Exclusion Criteria

- Children below 2 months and above 59 months were excluded from the study
- Children with documented evidence of comorbidities such as suspected or confirmed meningitis, HIV exposure or infection, severe acute malnutrition typically identified by the presence of visible severe wasting or edema, skin changes of kwashiorkor, and mid-upper-arm circumference <11.5 cm (from WHO reference charts), and chronic cardiorespiratory illnesses were excluded from the study
- Children with complications of pneumonia were excluded from the study.

Demographic data of all the children were recorded. Detailed clinical history was taken. Nutrition history including breastfeeding practices, immunization history,

and treatment history was taken. Children were divided into two groups: Group A: Consisted of children with weight for age <3rd percentile and Group B: Children with those with weight for age ≥3rd percentile. Age-wise categories were made from 0 to 12 months, 13 to 24 months, 25 to 36 months, 37 to 48 months, and 49 to 59 months. Investigations included radiological imaging with plain X-ray and ultrasonography wherever necessary. Hematological investigations such as complete blood picture, sputum examination, NP aspirates analysis for the organism, and blood cultures were done. The etiology was determined by microbiological, serological, and molecular tests. All the children were treated following the WHO guidelines: Recommendation 1: Children with fast breathing pneumonia with no chest in drawing or general danger sign were treated with oral amoxicillin: At least 40 mg/kg/dose twice daily (80 mg/kg/day) for 5 days. Children with fast breathing pneumonia who fail on first-line treatment with amoxicillin were treated with parenteral ampicillin (or penicillin) and gentamicin. Recommendation 2: Children age of 2–59 months with the chest in drawing pneumonia was treated with oral amoxicillin: At least 40 mg/kg/dose twice daily for 5 days. Recommendation 3: Children aged 2–59 months with severe pneumonia were treated with parenteral ampicillin (or penicillin) and gentamicin as a first-line treatment; ampicillin; 50 mg/kg, or benzylpenicillin: 50,000 units/kg IM/IV every 6 h for at least 5 days; gentamicin: 7.5 mg/kg IM/IV once a day for at least 5 days. Ceftriaxone was used as a second-line treatment in children with severe pneumonia having failed on the first-line treatment. The hospital stay was grouped as two; <1 week group and more than 1 week group; all the data collected were analyzed using standard statistical methods.

OBSERVATIONS AND RESULTS

Seventy-nine children diagnosed with symptoms of pneumonia attending the Department of Pediatrics, Viswabharathi Medical College Hospital, R T Nagar, Kurnool, were included in this study. There were 43 (54.43%) male children and 36 (45.56%) female children. The youngest child was 4 months old and the eldest child was aged 57 months old with a mean age of 28.4 ± 1.3 months. Children belonging to Group A were 40 (50.63%) and belonging to Group B were 39 (49.36%). The distribution of Group A and Group B patients in different age intervals is tabulated in Table 1. 62/79 (78.48%) of the children were aged from 0 to 36 months, which included both Groups A and B [Table 1].

Demographic data and nutrition history, including breastfeeding practices, immunization history, and treatment history, are tabulated in Table 2.

Among 79 children of this study 46/79 (58.22%) were diagnosed as "Pneumonia" of WHO typing (children with cold, cough, shortness of breath, and increased respiratory rate without chest in drawing) and the remaining 33/79 (41.77%) children as severe pneumonia (children with cold, cough, shortness of breath, and increased respiratory rate with chest in drawing). 62/79 (78.48%) children below 36 months (3 years) were found to have either pneumonia or severe pneumonia. 17/79 (21.51%) children belonged to the age group above 36 months were found to have either pneumonia or severe pneumonia in this study. 39/62 (62.90%) children who had pneumonia were below 36 months and 23/62 (37.9%) children who had severe pneumonia were below 36 months [Table 3]. It was observed that there was statistical difference in demographic observations such as gender, socio-economic status, breastfeeding, and immunization, among the two types of pneumonia in this study [Table 3], ($P < 0.05$; with $P < 0.05$). There was no statistical difference in demographic observations such as treatment before admission and a previous history of pneumonia ($P > 0.05$), [Table 4].

The incidence of two types of pneumonia among Groups A and B patients was observed and found that there was a statistically significant higher incidence of severe pneumonia in Group A patients than in Group B patients ($P < 0.05$), [Table 4].

The findings of radiological imaging, hematological investigations such as complete blood picture, sputum examination, NP aspirates analysis for the organism, and blood cultures are tabulated in Table 5. Out of 46 pneumonia cases, 16/46 (34.78%) children had bilateral infiltrates, 11/46 (23.91%) had unilateral infiltrates, 13/46 (28.26%) had lobar consolidation, and 6/40 (13.04%) had syn-pneumonic effusion [Table 5 and Figure 1]. Among the severe pneumonia children, 10/33 (30.30%) children had bilateral infiltrates, 11/33 (33.33%) had unilateral infiltrates, 10/33 (30.30%) had lobar consolidation, and 3/33 (9.095%) had syn-pneumonic effusion [Table 5]. In the pneumonia group, *Staphylococcus aureus* was isolated in 11/46 (23.91%) children, acinetobacter in 4/46 (8.69%) children, methicillin-resistant *S. aureus* (MRSA) in

Table 1: The incidence of weight for age among the children of the study (*n*-79)

Age in months (%)	Group A-40 (%)	Group B-39 (%)
0–12–21 (42.5)	11 (11.39)	10 (10.12)
13–24–23 (50)	12 (13.92)	11 (11.39)
25–36–18 (42.5)	9 (8.86)	9 (12.65)
37–48–9 (42.5)	3 (7.59)	6 (6.32)
49–59–8 (35)	5 (8.86)	3 (8.86)

Table 2: The demographic data of the study group (*n*-79)

Observations	0–12 months (21)	13–24 months (23)	25–36 months (18)	37–48 months (9)	49–59 months (8)
Socio-economic status					
Low–32	9	6	10	4	3
Middle–23	5	6	6	3	3
High–24	7	11	2	2	2
Breastfeeding history					
Present–69	20	20	17	7	5
Absent–10	1	3	1	2	3
Immunization					
Completed–62	17	21	16	5	3
Irregular–9	1	1	1	3	3
Absent–8	3	1	1	1	2
Treatment before admission					
Oral antibiotics–18	3	5	4	4	2
Parenteral antibiotics–20	3	5	6	3	3
No treatment–16	2	6	5	1	2
Symptomatic treatment–25	13	7	3	1	1
Previous history of pneumonia					
Present–10	2	3	3	1	1
Absent–69	19	20	15	7	8

Table 3: The demographic data in both pneumonia and severe pneumonia children in the study (*n*-79)

Observations	Pneumonia – 46 (58.22%)	Severe pneumonia – 33 (41.77%)
Age		
0–12–21	14	7
13–24–23	12	11
25–36–18	13	5
37–48–9	4	5
49–59–8	3	5
Gender		
Male–49	29	20
Female–30	17	13
Socio-economic status		
Low–37	22	15
Middle–21	12	9
High–21	12	9
Breastfeeding history		
Present–63	42	21
Absent–16	4	12
Immunization		
Completed–64	44	20
Irregular–9	1	8
Absent–6	1	5
Treatment before admission		
Oral antibiotics–15	9	6
Parenteral antibiotic–16	12	4
No treatment–24	13	11
Symptomatic treatment–24	12	12
Previous history of pneumonia		
Present–10	4	6
Absent–69	45	34

Table 4: The incidence of pneumonia according to age for weight percentile (*n*-79)

Age for weight of the children (%)	Pneumonia – 46 (%)	Severe pneumonia – 33 (%)
Group A–40 (50.63)	15 – (37.50)	25 – (62.5)
Group B–39 (49.36)	31 – (79.48)	8 – (20.51)

10/46 (21.73%) children, Coagulase-negative staphylococci in 12/46 children, and *Klebsiella* ion 9/46 (19.56%) children [Table 5]. In severe pneumonia group, *S. aureus* was isolated in 9/33 (27.27%) children, acinetobacter in 3/33 (9.09%) children, MRSA in 6/33 (18.18%) children, Coagulase-negative staphylococci in 8/33 (24.24%) children, and *Klebsiella* ion 7/33 (21.21%) children [Table 5].

Pneumonia group children (40), all age groups with fast breathing with no chest in drawing or general danger sign were treated with oral amoxicillin: 40 mg/kg/dose twice daily (80 mg/kg/day) for 5 days. When these children failed to this treatment with amoxicillin were treated with parenteral ampicillin (or penicillin) and gentamicin as a first-line treatment; ampicillin: 50 mg/kg, or benzylpenicillin: 50,000 units/kg IM/IV every 6 h for at least 5 days or gentamicin: 7.5 mg/kg IM/IV once a day for at least 5 days. In severe pneumonia children (39), of all age groups, parenteral antibiotics were started on the day of admission: Ampicillin: 50 mg/kg or benzylpenicillin: 50,000 units/kg IM/IV every 6 h for at least 5 days or gentamicin: 7.5 mg/kg IM/IV once a day for at least 5 days. Ceftriaxone was used as a second-line treatment in children with severe pneumonia having failed on the first-line treatment.

DISCUSSION

Pneumonia is an acute illness of lung in which the alveolar air spaces become inflamed and filled with fluid and white blood cells, giving rise to the appearance of consolidation on the chest radiograph. It can be caused by bacterial, viral, or parasitic infection, as well as by noninfectious agents. Most severe cases of pneumonia are caused by bacteria, of which the most important are S. pneumoniae

Table 5: The laboratory investigations in the study group (*n*-79)

Investigations	Pneumonia – 46 (58.22%)	Severe pneumonia – 33 (41.77%)
X-ray findings		
Bilateral infiltrates	16	10
Unilateral infiltrates	11	11
Lobar consolidation	13	9
Syn-pneumonic effusion	6	3
Hematological tests		
Neutrophilia	36	30
Lymphocytosis	10	3
Nasopharyngeal aspirate culture		
Positive	34	23
Negative	12	10
Bacteriological study		
Staphylococcus aureus	11	9
Acinetobacter	4	3
Methicillin-resistant *Staphylococcus aureus*	10	6
Coagulase-negative *Staphylococci*	12	8
Klebsiella	9	7
Sputum examination		
AFB positive	5	3
AFB negative	41	30

AFB: Acid-fast bacilli

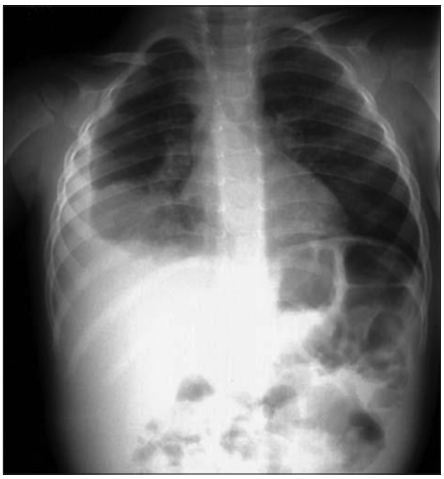

Figure 1: The right basal pneumonia

(Pneumococcus) and H. influenzae. According to the WHO, definition pneumonia is an acute illness with cough or difficulty breathing associated with an increased respiratory rate.[14] The incidence in children is more frequent than in adults. Deaths from pneumonia have been reduced by improving the living conditions, air quality, and nutrition in developed countries. However, in countries like India pneumonia are common causes of deaths in children due to multiple factors. Every year 1.9 million children under 5 years of age die from pneumonia.[15] On average, 2–3% of children in India each year have pneumonia severe enough to require hospitalization.[16] In this study, among 21/79 (26.58%) infants (0–12 months), 14/79 (17.72%) had pneumonia and 7 (8.86%) had severe pneumonia. Among the 23/79 (29.11%) children between 12 and 24 months age (Toddlers), 12/79 (15.18%) had pneumonia and 11/79 (13.92%) had severe pneumonia. Among the 18 children aged between 25 and 36 months, 13/79 had pneumonia and 5/79 (6.32%) had severe pneumonia. Totally, 62/79 (78.48%) children under the age of 3 years were with pneumonia. There was no significant difference in the incidence of severe pneumonia in infants and toddlers. However, when compared with 17/79 (21.51%) preschool children (37–59 months), the proportion of pneumonia was higher in children <3 years group. Therefore, infancy and toddler age formed a risk factor for the incidence of pneumonia with $P < 0.05$ and it was significant. However, the incidence of severe pneumonia was 23/62 (37.09%) in children under 3 years of age and 10/62 (16.12%) in preschool children [Table 6]. There are three challenges in formulating empirical treatment protocol in pneumonia of children according to the etiological agents. (1) Difficulty in obtaining specimens in lower respiratory tract infections in children as they cannot bring out sputum. Moreover, lung aspirations being an invasive procedure are not accepted by the parents and are done in small numbers.[16] However, because lung aspirates are invasive, they are only conducted at a small number of research centers in developing countries.[17,18] (2) The pathogens of pneumonia are fastidious and require sophisticated laboratory culture systems for growth or replication. (3) Existing tests for most pathogens that cause pneumonia are imperfect and there is, therefore, no gold standard against which to test new diagnostics. Isolation of organisms on the blood culture of patients with severe pneumonia is highly specific for bacterial pneumonia, but it has a sensitivity of <15%.[19] Multiplex polymerase chain reaction (PCR),[20,21] for example, the respiratory multi Code–PLx Assay (RMA; Era Gen Biosciences) integrates multiplex PCR with microsphere flow cytometry to allow simultaneous identification of eight groups of respiratory virus (RSV; parainfluenza virus; influenza A and influenza B; human rhinovirus; enteroviruses; metapneumovirus; adenovirus B, adenovirus C, and adenovirus E; and coronaviruses). Compared with conventional diagnostic methods, this technique increases the number of pathogen-positive samples roughly three-fold.[20] Detecting bacterial polysaccharides in urine with a simple immuno-chromatographic strip tests helps as a rapid diagnostic test for respiratory pathogens in adults, but in children this test lacks specificity as 60% of children are have meningococcal organisms as commensals in the nasopharynx.[22,23] In the present study, X-ray examination, sputum culture, blood examination, and NP aspirate studies are undertaken in confirming the diagnosis and the etiological agents which lack specificity. It was observed that there was statistical difference in demographic observations such as gender,

Table 6: The analysis of pneumonia and severe pneumonia groups versus predisposing factors (*n*-79)

Observation	Pneumonia group – 46	Severe pneumonia group – 33	Total	*P* value
Age				0.024
<3 years	39	23	62	
3 years	7	10	17	
Gender				0.091
Male	29	20	49	
Female	17	13	30	
Weight for age percentile				0.14
Weight for age <3 percentile	15	25	40	
Weight >3 percentile	31	8	39	
Breast feeding				0.043
Breastfed	42	21	63	
Not breastfed	4	12	16	
Vaccination				0.021
Vaccinated	45	28	73	
Not vaccinated	1	5	6	
Duration of hospital				0.12
Stay<1 week	20	18	38	
Stay>1 week	26	15	41	

socio-economic status, breastfeeding, and immunization, among the two types of pneumonia in this study [Table 3], ($P < 0.05$; with $P < 0.05$). Out of 46 pneumonia cases, 16/46 (34.78%) children had bilateral infiltrates, 11/46 (23.91%) had unilateral infiltrates, 13/46 (28.26%) had lobar consolidation, and 6/40 (13.04%) had Syn-pneumonic effusion [Table 5]. Among the severe pneumonia children, 10/33 (30.30%) children had bilateral infiltrates, 11/33 (33.33%) had unilateral infiltrates, 10/33 (30.30%) had lobar consolidation, and 3/33 (9.095%) had Syn-pneumonic effusion [Table 5]. Whereas the study done by Bharti *et al.* published in Indian pediatrics in 2008, out of 83 X-rays taken in severe pneumonia cases, lobar consolidation (n = 43, 51.8%) was the most common radiological abnormality, 26 (31.3%) had interstitial abnormalities, and 14 (16.9%) had normal chest radiographs.[24] In this study, bacterial culture was done in blood and either sputum or NP aspirate. In the pneumonia group, *S. aureus* was isolated in 11/46 (23.91%) children, acinetobacter in 4/46 (8.69%) children, MRSA in 10/46 (21.73%) children, coagulase-negative staphylococci in 12/46 children, and *Klebsiella* in 9/46 (19.56%) children [Table 5]. In severe pneumonia group, *S. aureus* was isolated in 9/33 (27.27%) children, acinetobacter in 3/33 (9.09%) children, MRSA in 6/33 (18.18%) children, coagulase-negative staphylococci in 8/33 (24.24%) children, and *Klebsiella* in 7/33 (21.21%) children [Table 5]. In a similar study by Karambelkar *et al.,* in West India reported that methicillin-sensitive *S. aureus*, *S. pneumoniae,* and *Klebsiella* species were the most common organisms isolated.[25] The other pathogens identified were MRSA, and *Pseudomonas* species. Blood culture was positive in 26 (23.63%) of cases whereas NP aspirates yielded organisms in 34 (31%) samples in the present study. Aroma and Aggarwal reported blood culture positivity in 21.9% cases of severe pneumonia.[26] In this study, it was positive in 15/79 children (18.98%) only. In this study, oral amoxicillin administered at hospital for the first 48 h was effective in treating WHO defined severe pneumonia in 38/79 (48.18%) children who were otherwise clinically stable and did not have comorbid conditions. The remaining patients required recommendations 2 and 3 of the WHO protocol. Hospital stay for <1 week was seen in 38 (48.18%) of children and more than 1 week in 41 (51.89%) children.

CONCLUSIONS

Pneumonia is a clinically curable disease when identified and initiated on recommended treatment protocols. Lack of exclusive breastfeeding till 6 months of age, failure of complete immunization coverage, child malnutrition, infancy, and toddler age are the risk factors for both types of the pneumonia but more so with severe pneumonia. There was no statistical significance correlating the X-ray findings and severity of pneumonia was observed. Bacterial cultures of blood and NP/induced sputum have grown predominantly *Staphylococcus* and *Klebsiella pneumoniae* in this study. Amoxicillin oral route to start with and parenteral route when not responding to the oral route remains the drug of choice. The second-line antibiotic of choice was ceftriaxone sodium parenterally. The hospital stay was minimized with good supportive therapy.

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